sion to regard the eclipse-observations as a principal subject of attention, I shall have no excuse for not prosecuting preliminary arrangements, and for not forwarding fuller information of my success or otherwise.

" I am, Sir, yours very truly,

" J. HERSCHEL."

March 12, 1868.

Dr. WILLIAM ALLEN MILLER, Treasurer and Vice-President, in the Chair.

The following communications were read:—

I. "Notes on the Chemical Geology of the Gold-fields of California." By J. ARTHUR PHILLIPS. Communicated by Prof. A. C. RAMSAY. Received February 22, 1868.

(Abstract.)

Rocks of the Gold-Regions of California.—The great sedimentary metallic belt of California lies on the western slope of the Sierra Nevada, beginning in the neighbourhood of the Tejou Pass, and extending through the state to its northern limit. In consequence, however, of various local circumstances, different portions of this band are of very unequal importance as gold-producing districts.

The slates of the auriferous belt have been shown by Professor Whitney to belong, for a great extent, to the Jurassic period, although the occurrence of numerous Triassic fossils in the gold-bearing rocks of Plumas County and elsewhere renders it more than probable that no inconsiderable portion of the slates in the heart of the gold region are of that age.

The rock constituting the principal mass of the Sierra Nevada is a granite containing only a small proportion of quartz, and in which but one species of felspar (oligoclase) is generally found.

Lying between the band of metamorphic slates and the great central mass of granite forming the more elevated portions of the chain, are found various crystalline rocks, such as syenites, diorites, and porphyries.

Quartz Veins.—The matrix or gangue of the auriferous veins of California is invariably quartz, which is generally crystalline in its structure, or partially vitreous and semitransparent. In the majority of cases the quartz constituting an auriferous veinstone is ribboned in such a way as to form a succession of layers parallel with the walls of the lode itself; and some one or more of these laminæ are not unfrequently far more productive than all the others. In some instances these parallel bands are separated from each other by a thin layer of quartz, slightly differing, either in colour or structure, from that forming the seams themselves; or they may be only distinguished by a difference of colour of two adjoining members of the series.

In many cases, however, laminæ of the enclosing slates divide the vein into distinct bands; and in such instances it will be observed that the thickness of the interposed fragments of slate is sometimes not greater than that of a sheet of the thinnest paper. Cavities or druses containing crystals of quartz occur in all the auriferous veins of the country; and a certain amount of crystallization may also not unfrequently be remarked along the lines of junction of the several bands of which a vein is composed. In addition to ordinary quartz, in a more or less crystalline form, amorphous hydrated silica, or semiopal, and chalcedony are occasionally met with: in some instances the opal is interfoliated between layers of true quartz, and is sufficiently auriferous to repay the expenses of treatment.

The metallic minerals enclosed in the gangue of auriferous veins are ordinary iron pyrites, blende, and galena, and, less frequently, arsenical pyrites, magnetic and copper pyrites, and cinnabar. These sulphides invariably contain gold; and veins in which some one or more of them does not occur, in considerable amounts, are not regularly and lastingly productive.

Near the surface the iron pyrites and other sulphides become decomposed by the action of air and the percolation of meteoric water through the mass, staining the quartz of a red or brown colour, and leaving the gold in a free state. Under such circumstances numerous cubical moulds of iron pyrites are found in the veinstone; and although this mineral has been entirely removed by chemical action, the cavities left contain finely divided gold, obviously liberated by the decomposition of pyrites.

Beneath the line of natural drainage of the country the sulphides remain undecomposed; but if rock containing pyrites be placed in nitric acid the sulphide becomes dissolved, and finely divided, crystalline, or filiform gold will partially occupy the resulting cavities.

In one of the detrital beds in the vicinity of the village of Volcano in the County of Amador, and elsewhere, distinctly marked quartz veins may be observed cutting through the gravel, and evidently formed by the action of water holding silica in solution.

Attention has also been recently directed to bands of auriferous slate found in the copper-bearing belt west of the main gold-belt of the State, and in the foot hills of the Sierra. In this locality the gold, instead of being obtained from a well-defined vein, chiefly composed of ordinary quartz, is enclosed in a band of siliceous slaty rock, extending north-west and south-east, and dipping in conformity with the other strata of the district.

The number of fluid-cavities contained in the veinstones of the auriferous lodes of California is seen under the microscope to be exceedingly limited; and in order to obtain sections affording good examples, even of small size, it is necessary to select such bands as may be more than ordinarily crystalline, or to operate on thin fragments of crystals sometimes found lining the interior of drusy cavities. In the more opaque and generally

most auriferous portions of veins, the cavities are numerous but exceedingly small, and are often so opaque, apparently rendered so by being internally coated with a lining of clay, that no vacuities can be distinguished.

Out of more than fifty sections of veinstone examined, only some six or seven were found to contain fluid-cavities of sufficient size to admit of any attempt at accurate measurement by means of ordinary appliances; but in all cases there appeared to be considerable differences in the relative dimensions of the vacuities and the enclosing cavities, and the temperatures at which they severally became filled were consequently ascertained by direct experiment. In every instance they were found to require very different degrees of heat to become full, since in the same specimens some of the vacuities disappeared at 180° Fahr., others filled at temperatures slightly above that of boiling water, whilst many, though much reduced in size, remained perfectly visible at 365° Fahr.

Alluvial Deposits.—Although a very large amount of the gold annually obtained was no doubt originally derived from auriferous veins, not more than about one-third of the precious metal collected is procured directly from that source. The larger proportion of the gold now brought into the market is derived from alluvial diggings, in which it is separated by washing from the clay, sand, and gravel with which it is associated.

This gold-bearing drift belongs to at least two distinct geological epochs, both comparatively modern—although the latter period is distinctly separated from the earlier, its materials being chiefly derived from the disintegration and redistribution of the older deposits.

In California the more ancient deposits or "deep placers" are referable to a river-system different from that which now exists, flowing at a higher level, and frequently nearly at right angles to the direction of the main valleys of the present period.

The deep placers are in many localities covered by a thick capping of lava; and the eruptive matter covering them often occurs in the form of basaltic columns, beneath which are found the layers of sand, gravel, and boulders with which the gold is associated. The wood which occurs in these gravel-beds is either beautifully silicified, or is replaced by iron pyrites.

In the more clayey strata of these deposits leaf-beds and impressions of leaves are not unfrequently found; and an examination of these made by Dr. Newberry authorizes the conclusion that the auriferous deposits lying beneath the lava are of tertiary age, and that they probably belong to the later Pliocene epoch. Water-worn gold is disseminated throughout the whole mass of these deposits, not, however, with uniformity, but always in greater abundance near the bottom, and more particularly in direct contact with the "bed rock," which is invariably grooved and worn by the action of water.

The materials of which these deep placers are composed are frequently consolidated into a sort of hard concrete, by being firmly bound together

by crystalline iron pyrites; and sometimes this cementing material consists either of carbonate of lime or silica. The silica is rarely met with in a crystalline form; but near Kenebeck Hill a cavity, resulting from the junction of several pebbles, was found completely lined with well-defined crystals of quartz. These did not show, under the microscope, the usual fluid-cavities of quartz of the ordinary quartz veins of the country.

Where the cementing material of the conglomerate chiefly consists of pyrites, the enclosed trunks of trees are usually replaced by that mineral, although, of two pieces of wood lying in close proximity to each other, one may have become silicified, whilst the other is replaced by iron pyrites.

The assay of several specimens of the cementing pyrites showed that it invariably contained a certain but very variable amount of gold. In order to ascertain whether this exists in the form of water-worn grains mechanically enclosed within the sulphide, or in the form of spongy, crystalline, and filamentary particles, similar to those met with in the pyrites of auriferous veins, various samples were dissolved in nitric acid, and the residues afterwards subjected to microscopical examination. In this way granules of the precious metal, which had evidently been worn by the action of water, were detected, whilst others appeared not to have been subjected to such attrition. Mr. Ulrich states that in the gold-drifts of Australia pyrites is often found replacing roots and driftwood, and that samples have, on assay, yielded from a few pennyweights to several ounces of gold per ton.

Hot Springs.—Hot and boiling springs are exceedingly numerous throughout California; and considerable accumulations of sulphur, together with evidences of extensive solfatara action, are met with in different sections of the State.

The most remarkable instance on the Pacific coast of the actual growth, on a large scale, and at the present time, of mineral veins is probably that afforded by the boiling springs in Steamboat Valley, about seven miles north-west of the great Comstock silver vein in the State of Nevada.

These springs are situated at a height of about 5000 feet above the level of the sea, at the foot of the eastern declivity of the Sierra Nevada. The rock in this locality presents several straight and parallel fissures, either giving out heated water or simply ejecting steam. The first group of crevices comprises five longitudinal springs extending in a straight line, and parallel to each other, for a distance of above 3000 feet. These fissures are partially filled by a siliceous incrustation, which is being constantly deposited on the sides, whilst a longitudinal central crevice allows of the escape of boiling water or steam. On the most eastern of these lines of fracture are five active centres of eruption, from which boiling water is sometimes ejected by the force of steam to a height of from 8 to 10 feet. These waters are alkaline, and contain, in addition to carbonate of soda, the sulphate of that base, together with chloride of sodium.

There is also everywhere an escape of carbonic acid, whilst from some places sulphuretted hydrogen is also evolved. These products, on arriving at the surface, give rise to the deposition of sulphur, silica, and anhydrous oxide of iron. The silica and oxide of iron form semicrystalline bands parallel with the walls of the fissures; and spongy deposits accumulate around some of the points of most active emergence.

At a considerable distance to the west of those above described, a fissure having the same origin is observed; but this is no longer traversed by currents of hot water, although it still gives off steam and carbonic acid at various points throughout its extent. At its northern extremity a central fissure still remains open; but in other localities it is, for the most part, obstructed by siliceous concretions. This siliceous rock is metalliferous, and, in addition to oxide of iron and manganese, contains iron and copper pyrites. M. Laur states that he also discovered metallic gold in this deposit.

The rock enclosing the veins of Steamboat springs is granite, which in their vicinity is much decomposed, being often reduced to a cavernous skeleton of silica containing a few scales of mica.

Alkaline Lakes.—In that portion of California lying on the east of the Sierra Nevada are Mono Lake and Owen's Lake, both considerable sheets of water, highly impregnated with alkaline salts. Owen's Lake lies in lat. 36° 20″ south, long. 118° west from Greenwich, and is about twenty miles in length and eight in width.

The waters of this lake have a specific gravity of 1·076, and contain 7128·24 grs. of solid matter per gallon. The salts held in solution are chiefly carbonate and sulphate of soda, with chloride of sodium; but potash, silica, and phosphoric acid are also present.

The incrustations, which at certain seasons of the year are found to the extent of many hundreds of tons, consist of a white spongy efflorescence, and are, as will be seen from the results of the analysis given in the paper, chiefly composed of carbonate of soda, mixed with a little chloride of sodium and sulphate of soda.

General deductions.—The author remarks that, in the present state of our knowledge, the results of a careful examination of the gold-regions of the Pacific coast would appear to lead to the following conclusions:—

a. Quartz veins have generally been produced by the slow deposition from aqueous solutions of silica on the surfaces of the enclosing fissures.

b. From the general parallelism with its walls of the planes of any fragments of the enclosing rock which may have become imbedded in a vein, it is to be inferred that they were mechanically removed by the growth of the several layers to which they adhered, and that a subsequent deposition of quartz took place between them and the rock from which they had become detached. In this way were introduced the masses of rock known as "horses."

c. The formation of quartz veins is due to hydrothermal agencies, of

which evidences are still to be found in the hot springs and recent metalliferous veins met with in various parts of the Pacific coast.

d. From the variable temperatures at which the vacuities in their fluid-cavities become filled, it may be inferred that they are the result of an intermittent action, and that the fissures were sometimes traversed by currents of hot water, whilst at others they gave off aqueous vapour or gaseous exhalations. This is precisely what is now taking place at Steamboat springs, where the formation of a vein is in progress, and from which currents of boiling water are often poured forth, whilst at other times the fissures give off currents of steam and heated gases only.

e. That gold may be deposited from the same solutions which give rise to the formation of the enclosing quartz, appears evident from the presence of that metal in pyrites enclosed in siliceous incrustations, as well as from the fact of large quantities of gold having been found in the interior of the stems of trees, which in deep diggings are often converted into pyrites.

f. The constant presence of iron pyrites in auriferous veins, and when so occurring its invariably containing a certain amount of gold, suggests the probability of this sulphide being in some way necessarily connected with the solvent by which the precious metal was held in solution. It has been shown that finely divided gold is soluble in the sesquichloride of iron and, more sparingly, in the sesquisulphate of that metal. It is also well known that iron pyrites sometimes results from the action of reducing agents on the sulphates of that metal. If therefore sulphate of iron, in a solution containing gold, should become transformed by the action of a reducing agent into pyrites, the gold, at the same time being reduced to the metallic state, would probably be found enclosed in the resulting crystals of that mineral.

g. The silica and other substances forming the cementing material of the ancient auriferous river-beds have probably been slowly deposited at a low temperature.

The connexion existing between the decomposition of granite by the agency of boiling springs, the existence of alkaline plains, and the formation o f lakes containing various salts of soda and potash, is too obvious to require comment.

II. "Third Supplementary Paper on the Calculation of the Numerical Value of Euler's Constant." By William Shanks. Communicated by the Rev. B. Price. Received February 29, 1868.

When $n=5000$, we have

$1+\frac{1}{2}+\frac{1}{3}+\ldots\frac{1}{5000}=$

9·09450 88529 84436 96726 12455 33393 43939 17829
87811 30384 14506 16283 86638 30530 78016 46808
46902 09226 85495 77084+